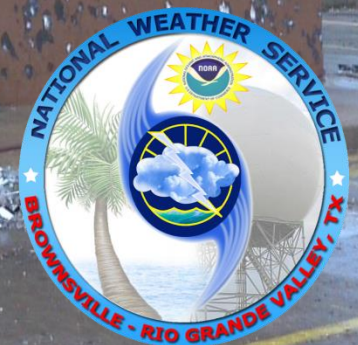


# Impact Based Warnings (IBW): Clarifying the Message for Thunderstorm Wind, Hail, and Tornadoes

Barry S. Goldsmith  
Warning Coordination Meteorologist  
National Weather Service Brownsville/Rio Grande Valley, Texas



McAllen, March 30, 2012



# Impact Based Warnings

## The Overview

### Goals:

- Provide additional valuable information to media and Emergency Managers
  - Facilitate improved public response and decision making
  - Better meet societal needs in the most life-threatening weather events
- 
- Experimental Product in 2015; Final Implementation Dependent on Success Over Several Years





# What Is IBW?

- An alert mechanism for communicating elevated levels of threat from thunderstorm wind, hail, and tornadoes
- A small change in the warning message without affecting the format (examples to follow)
- Warnings traditionally have included the following:
  - ***What.*** Causative event
  - ***Where.*** Counties, cities, communities affected
  - ***When/How Long.*** Duration of warning and tracking information
  - ***So What?*** Recommended Actions to Take to Protect Life/Property
- IBW Retains the “Where, When/How Long, and So What” but now...
  - **Clarifies the “What”.** Don’t know what “severe thunderstorm” means by NWS definition? Now you’ll know what we’re describing – wind speed, hail size, and tornado intensity.
  - **Adds the “What Will Happen?” – Impacts!!**



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# Why IBW?

- Despite excellent Tornado Warning Accuracy and Lead Time, nearly 550 died in Alabama, Mississippi, Missouri, etc., in 2011  
Fact: 97% of tornado deaths occurred in EF2-5 tornadoes (111 mph or higher)
- Independent studies of the Joplin tornado (May 2011) by NWS and NIST found a need to communicate levels of tornado threat.
  - Level of threat informs risk. For example, a single family home rated to withstand 90 mph winds will be at high risk for destruction from an EF-3 tornado (136+ mph) but a low risk for destruction at EF-0 (65-85 mph).
- Additional studies found that people would be more likely to shelter - and more quickly shelter – given “consequence”-based messaging (Ripberger et. al; Casteel et. al, 2014)
- Allows forecasters to discriminate between low end (significant) and higher end (potentially devastating to catastrophic) outcomes
- **Allows you, the core partner, to do the same for your real-time decision making!**



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# Severe Thunderstorm Warning: Before (April 24, 2015 Weslaco/Donna Microburst

SEVERE THUNDERSTORM WARNING

NATIONAL WEATHER SERVICE BROWNSVILLE TX

1036 PM CDT FRI APR 24 2015

THE NATIONAL WEATHER SERVICE IN BROWNSVILLE HAS ISSUED A

\* SEVERE THUNDERSTORM WARNING FOR...

What Is This?

SOUTHEASTERN HIDALGO COUNTY IN DEEP SOUTH TEXAS...

\* UNTIL 1100 PM CDT

\* AT 1035 PM CDT...DOPPLER RADAR INDICATED A SEVERE THUNDERSTORM  
CAPABLE OF PRODUCING DESTRUCTIVE WINDS IN EXCESS OF 70 MPH. THIS  
STORM WAS LOCATED 7 MILES SOUTHWEST OF HIDALGO...AND MOVING  
NORTHEAST AT 40 MPH. PENNY SIZE HAIL MAY ALSO ACCOMPANY THE  
DAMAGING WINDS.

"Burying the Lead?"

\* LOCATIONS IMPACTED INCLUDE...

MCALLEN...EDINBURG...MISSION...PHARR...WESLACO...SAN JUAN...  
ALAMO...DONNA...MERCEDES...HIDALGO...MISSION FIRE STATION NUMBER  
5...DONNA POLICE DEPARTMENT...PHARR MEMORIAL LIBRARY...PSJA HIGH  
SCHOOL...HIDALGO HIGH SCHOOL...MISSION FIRE STATION NUMBER 3...  
MCALLEN HIGH SCHOOL...SAN JUAN MUNICIPAL COURT...ROWE HIGH SCHOOL  
AND DONNA CITY HALL.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

SEVERE THUNDERSTORMS PRODUCE DAMAGING WINDS...DESTRUCTIVE HAIL...  
DEADLY LIGHTNING AND VERY HEAVY RAIN. FOR YOUR PROTECTION...MOVE TO  
AN INTERIOR ROOM ON THE LOWEST FLOOR OF YOUR HOME OR BUSINESS. HEAVY  
RAINS FLOOD ROADS QUICKLY SO DO NOT DRIVE INTO AREAS WHERE WATER

COVERS THE ROAD.

DOPPLER RADAR HAS INDICATED SOME WEAK ROTATION WITHIN THIS STORM.

ALTHOUGH A TORNADO IS NOT IMMEDIATELY LIKELY. IF ONE IS SPOTTED...  
ACT QUICKLY AND MOVE TO A PLACE OF SAFETY IN A STURDY STRUCTURE...  
SUCH AS A BASEMENT OR SMALL INTERIOR ROOM.

IN ADDITION TO LARGE HAIL AND DAMAGING WINDS...CONTINUOUS CLOUD TO  
GROUND LIGHTNING IS OCCURRING WITH THIS STORM. MOVE INDOORS  
IMMEDIATELY. LIGHTNING IS ONE OF NATURE'S LEADING KILLERS. REMEMBER...  
IF YOU CAN HEAR THUNDER...YOU ARE CLOSE ENOUGH TO BE STRUCK BY  
LIGHTNING.

TORRENTIAL RAINFALL IS ALSO OCCURRING WITH THIS STORM...AND MAY LEAD  
TO FLASH FLOODING. DO NOT DRIVE YOUR VEHICLE THROUGH FLOODED  
ROADWAYS.

&&

LAT...LON 2604 9808 2605 9807 2607 9808 2607 9813

2605 9815 2607 9818 2606 9819 2607 9825

2610 9829 2612 9827 2612 9828 2610 9830

2617 9834 2616 9837 2634 9821 2624 9787

2607 9786 2605 9797 2607 9803 2604 9804

TIME...MOT...LOC 0335Z 236DEG 38KT 2600 9831

Impact Info  
Sometimes Buried  
Here





# Severe Thunderstorm Warning:

## IBW Now (April 24, 2015 Weslaco/Donna Microburst

SEVERE THUNDERSTORM WARNING

NATIONAL WEATHER SERVICE BROWNSVILLE TX

1036 PM CDT FRI APR 24 2015

THE NATIONAL WEATHER SERVICE IN BROWNSVILLE HAS ISSUED A

\* SEVERE THUNDERSTORM WARNING FOR...

SOUTHEASTERN HIDALGO COUNTY IN DEEP SOUTH TEXAS...

\* UNTIL 1100 PM CDT

\* AT 1035 PM CDT...A SEVERE THUNDERSTORM WAS LOCATED 7 MILES SOUTHWEST OF HIDALGO AND MOVING NORTHEAST AT 40 MPH.

HAZARD...70 MPH WIND GUSTS.

SOURCE...RADAR INDICATED.

IMPACT...EXPECT CONSIDERABLE TREE DAMAGE. DAMAGE IS LIKELY TO MOBILE

HOUSES...ROOFS...AND OUTBUILDINGS. SOME HOMES AND BUSINESSES WILL

LIKELY EXPERIENCE MINOR DAMAGE TO ROOFS, GABLES, AND AWNINGS.

\* LOCATIONS IMPACTED INCLUDE...

MCALLEN...EDINBURG...MISSION...PHARR...WESLACO...SAN JUAN...

ALAMO...DONNA...MERCEDES...HIDALGO...MISSION FIRE STATION NUMBER

5...DONNA POLICE DEPARTMENT...PHARR MEMORIAL LIBRARY...PSJA HIGH

SCHOOL...HIDALGO HIGH SCHOOL...MISSION FIRE STATION NUMBER 3...

MCALLEN HIGH SCHOOL...SAN JUAN MUNICIPAL COURT...ROWE HIGH SCHOOL

AND DONNA CITY HALL.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

FOR YOUR PROTECTION...MOVE TO AN INTERIOR ROOM ON THE LOWEST FLOOR OF YOUR HOME OR BUSINESS.

**Tied to "Tornado Possible" Tag**

DOPPLER RADAR HAS INDICATED SOME WEAK ROTATION WITHIN THIS STORM. ALTHOUGH A TORNADO IS NOT IMMEDIATELY LIKELY...IF ONE IS SPOTTED, ACT QUICKLY AND MOVE TO A PLACE OF SAFETY IN A STURDY STRUCTURE...SUCH AS A BASEMENT OR SMALL INTERIOR ROOM.

CONTINUOUS CLOUD TO GROUND LIGHTNING IS OCCURRING WITH THIS STORM. MOVE INDOORS IMMEDIATELY. LIGHTNING IS ONE OF NATURE'S LEADING KILLERS. REMEMBER...IF YOU CAN HEAR THUNDER...YOU ARE CLOSE ENOUGH TO BE STRUCK BY LIGHTNING.

**Lightning Not in "Severe" Definition but Important Life-Threat**

TORRENTIAL RAINFALL IS ALSO OCCURRING WITH THIS STORM...AND MAY LEAD TO FLASH FLOODING. DO NOT DRIVE YOUR VEHICLE THROUGH FLOODED ROADWAYS.

**Seldom Used but may be for below flood advisory ("nuisance") levels at first**

66

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2617 9834 2616 9837 2634 9821 2624 9787

2607 9786 2605 9797 2607 9803 2604 9804

TIME...MOT...LOC 0335Z 236DEG 38KT 2600 9831

WIND...70MPH

HAIL...<.75IN

TORNADO...POSSIBLE

**Hazard Tags**



# Getting the Most “Bang” from IBW

**HAZARD...70 MPH WIND GUSTS.**

**SOURCE...RADAR INDICATED.**

**IMPACT...EXPECT CONSIDERABLE TREE DAMAGE. DAMAGE IS LIKELY TO MOBILE HOMES...ROOFS...AND OUTBUILDINGS. SOME HOMES AND BUSINESSES WILL LIKELY EXPERIENCE MINOR DAMAGE TO ROOFS...GABLES...AND AWNINGS.**

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TIME...MOT...LOC 0335Z 236DEG 38KT 2600 9831

**WIND...70MPH**

**HAIL...<.75IN**



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# Getting the Most “Bang” from IBW

**HAZARD...70 MPH WIND GUSTS.**

**SOURCE...RADAR INDICATED.**

**IMPACT...EXPECT CONSIDERABLE TREE DAMAGE. DAMAGE IS LIKELY TO MOBILE HOMES...ROOFS...AND OUTBUILDINGS. SOME HOMES AND BUSINESSES WILL LIKELY EXPERIENCE MINOR DAMAGE TO ROOFS...GABLES...AND AWNINGS.**

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2607 9786 2605 9797 2607 9803 2604 9804

TIME...MOT...LOC 0335Z 236DEG 38KT 2600 9831

**WIND...70MPH**

**HAIL...<.75IN**



Consider:

- How About an “App for That”!
- Expansion of Wireless Emergency Alerts Beyond Tornado/Flash Flood?
- Media Partners: “Scrawls” That ‘Pull’ This Information Using Tags
- Tweetable: Hazard and Impact, Even for Higher End, Generally in 140 Character Range



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# Impact Based Warning Experimental Product



THE NATIONAL WEATHER SERVICE IN SPRINGFIELD HAS ISSUED A  
\* TORNADO WARNING FOR...  
NORTHWESTERN NEWTON COUNTY IN SOUTHWEST MISSOURI...  
SOUTHEASTERN CHEROKEE COUNTY IN SOUTHEAST KANSAS...  
SOUTHWESTERN JASPER COUNTY IN SOUTHWEST MISSOURI...  
THIS INCLUDES THE CITY OF JOPLIN...  
\* UNTIL 600 PM CDT.

\* AT 514 PM CDT...A TORNADO EMERGENCY FOR THE CITY OF JOPLIN.  
A CONFIRMED LARGE AND DESTRUCTIVE TORNADO WAS LOCATED NEAR  
BAXTER SPRINGS MOVING NORTHEAST AT 40 MPH.

THIS IS A PARTICULARLY DANGEROUS SITUATION.  
HAZARD...DEADLY TORNADO AND BASEBALL SIZE HAIL  
SOURCE...SPOTTERS AND LAW ENFORCEMENT CONFIRMED TORNADO.  
SIGNIFICANT DAMAGE TO HOMES REPORTED IN THE OAKS  
SUBDIVISION.

IMPACT...LIFE THREATENING SITUATION. EXTENSIVE DAMAGE TO HOMES  
AND BUILDINGS...UPROOTED TREES AND DEBRIS WILL  
RESTRICT ACCESS INTO MANY AREAS.

\* OTHER LOCATIONS IN THE WARNING...JOPLIN.  
PRECAUTIONARY/PREPAREDNESS ACTIONS...  
IF YOU ARE IN OR NEAR JOPLIN TAKE COVER IMMEDIATELY!  
&&  
LAT...LON 3716 9479 3707 9426 3697 9430 3701 9479  
TIME...MOT...LOC 2216Z 247DEG 36KT 3708 9470

TORNADO...OBSERVED  
TORNADO DAMAGE THREAT...CATASTROPHIC  
HAIL...2.75IN

## Tornado Tag

### TORNADO...RADAR INDICATED

Evidence on radar and near storm environment is supportive of a tornado. A tornado may be developing or ongoing, but no confirmation has been received.

### TORNADO...OBSERVED

Tornado is confirmed by spotters, law enforcement, etc.

## Tornado Damage Threat Tag

### TORNADO DAMAGE THREAT...CONSIDERABLE

There is credible evidence that a tornado, capable of producing considerable damage, is imminent or ongoing.

### TORNADO DAMAGE THREAT...CATASTROPHIC

A severe threat to human life and catastrophic damage from a tornado is occurring. This will only be used when reliable sources confirm a violent tornado.

## Tornado Tag In Severe Thunderstorm Warnings

### TORNADO...POSSIBLE

A severe thunderstorm has some potential for producing a tornado although forecaster confidence is not high enough to issue a Tornado Warning.





# RGV IBW Rulebook - Preface



- We are *\*not\** Kansas!
- Special Tornado IBW will be *very limited* here...
  - ...Except for the “Tornado Possible” Tag on **Severe Thunderstorm Warnings**, which will match how we apply confidence in potential
- Wind somewhat limited, but there are cases
- Hail mainly limited by number of events
  - i.e. our hail events are more like Kansas than Florida



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# RGV IBW Rulebook: Tornado

- **EF2 to EF5 Warrants “Considerable” Tag**
  - When was the Last EF2 in the RGV? Answer: 1983!!)
  - How Often Do We See the Necessary Radar Signature? (Answer: Almost Never)
- **EF1? In Nearly All Cases, Standard TOR** (no IBW Tag)
  - One Exception: Sufficient Radar Signature and Verified Ongoing Damage Prior to Reaching Colonias/Mobile Home Parks
  - GIS Neighborhood Data Key to Knowledge
- Soooo....



Hebbbronville, July 2 2010 EF-1

**The Vast Majority of Our Tornado Warnings:**

**Tornado IBW Tag/Wording “Considerable”:**

**Tornado IBW Tag/Wording “Catastrophic”:**

**No Special Tags**

**Extremely Rare**

**Almost NEVER**



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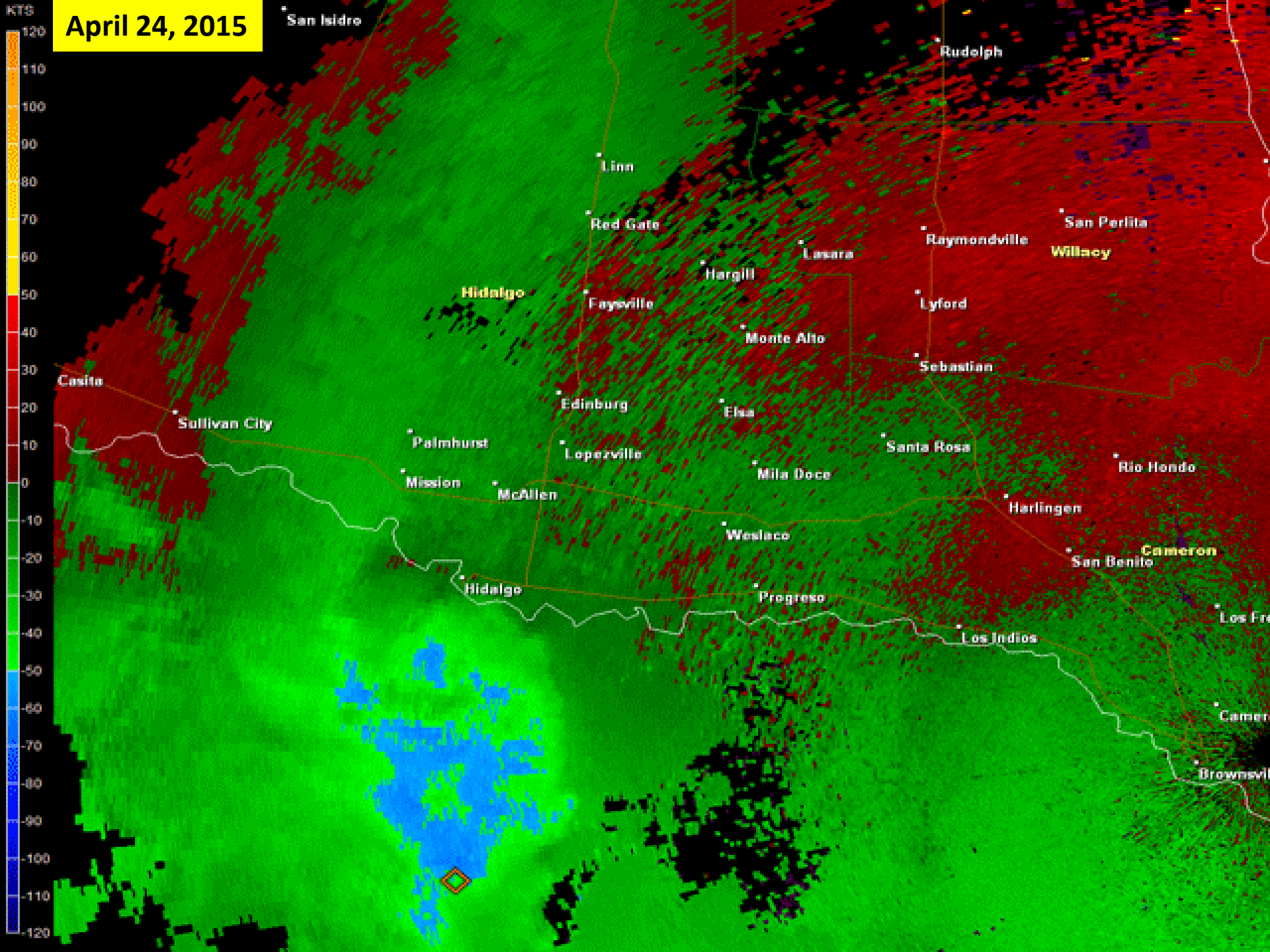
# RGV IBW Rulebook: Wind

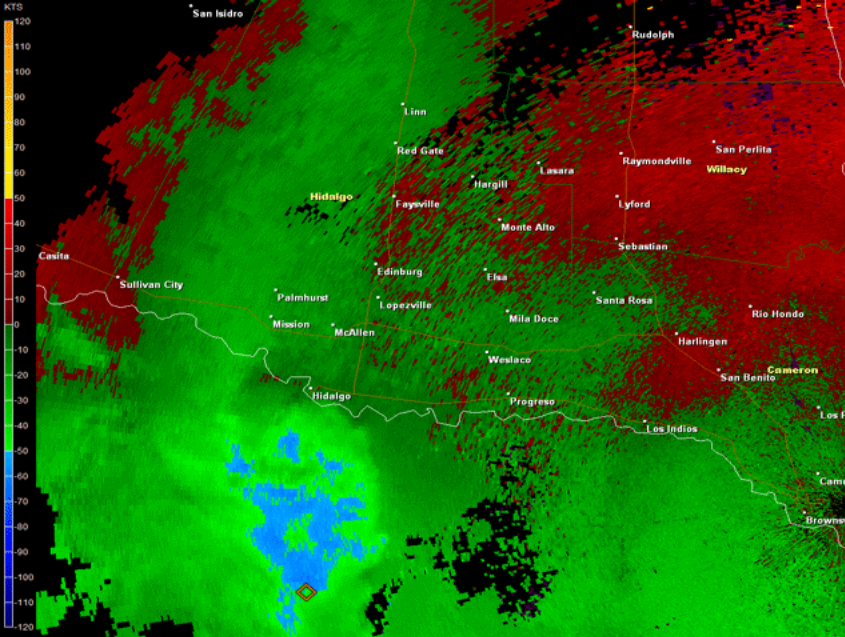
- 60 mph tag/wording (Standard Severe Thunderstorm Warning) – Majority of our cases.
- 70 mph tag/wording: **Seldom** (see example to follow)
- 80 mph tag/wording: **Rare** (see example to follow)
- 90 mph tag/wording: **Extremely Rare** (see example)
- 100 mph tag/wording: **Almost NEVER**.

15 9:15AM



April 24, 2015





# The Seldom Case

**HAZARD...70 MPH WIND GUSTS.**

**SOURCE...RADAR INDICATED.**

**IMPACT...EXPECT CONSIDERABLE TREE DAMAGE. DAMAGE IS LIKELY TO MOBILE HOMES...ROOFS...AND OUTBUILDINGS. SOME HOMES AND BUSINESSES WILL LIKELY EXPERIENCE MINOR DAMAGE TO ROOFS...GABLES...AND AWNINGS.**

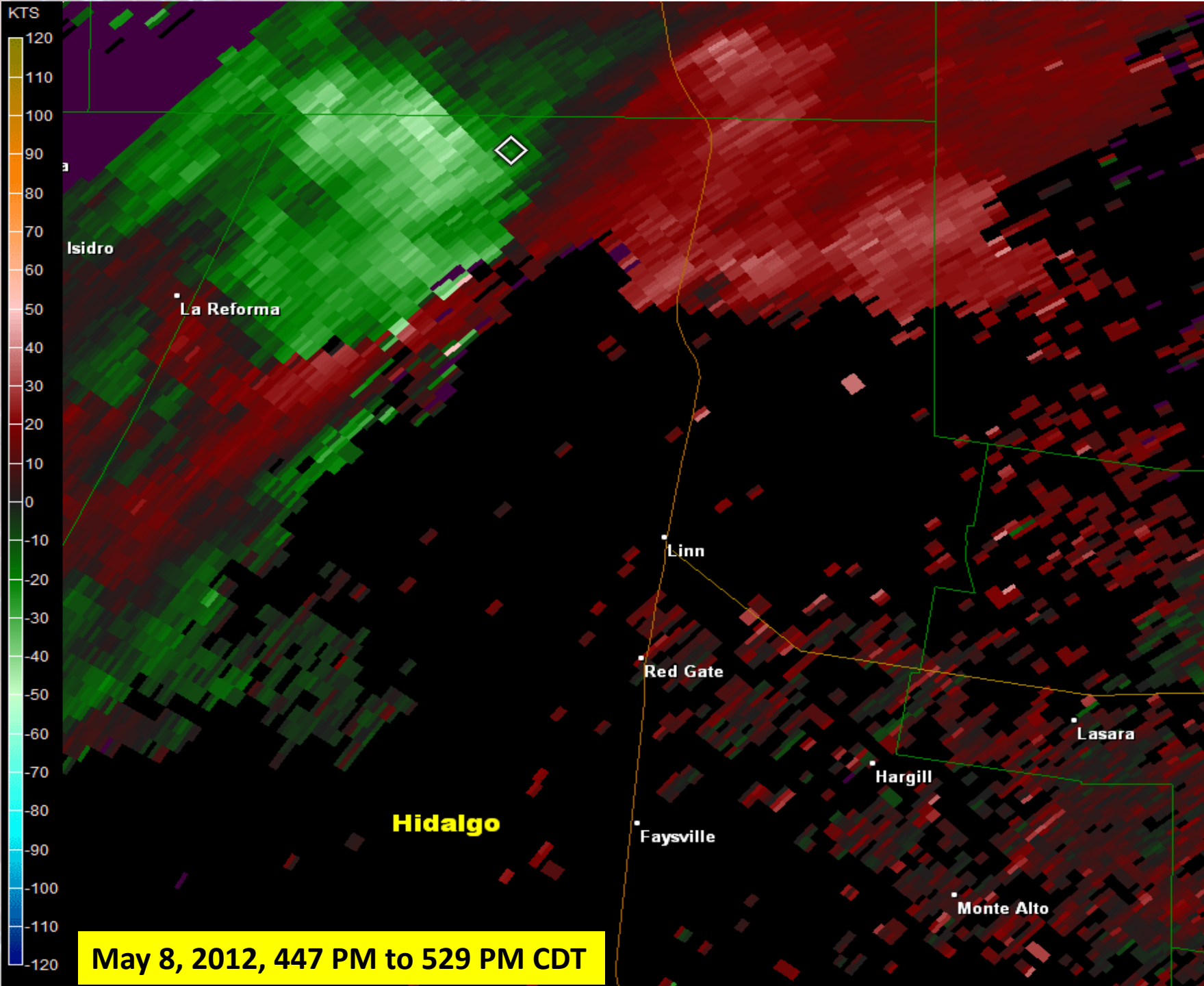
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2607 9786 2605 9797 2607 9803 2604 9804

TIME...MOT...LOC 0335Z 236DEG 38KT 2600 9831

**WIND...70MPH**  
**HAIL...<.75IN**







# The Rare/Extremely Rare Case



Pink Area: 85-90 knots (at ~5000 feet above ground)

**HAZARD...90 MPH WIND GUSTS.**

**SOURCE...RADAR INDICATED.**



**IMPACT... YOU ARE IN A LIFE THREATENING SITUATION! FLYING DEBRIS MAY BE DEADLY TO THOSE CAUGHT WITHOUT SHELTER. MOBILE HOMES WILL BE HEAVILY DAMAGED OR DESTROYED. HOMES AND BUSINESSES WILL LIKELY HAVE SUBSTANTIAL ROOF AND WINDOW DAMAGE. EXPECT EXTENSIVE TREE DAMAGE AND POWER OUTAGES.**



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# RGV IBW Rulebook: Hail

- No **Damage** Wording, only **Size** Wording
  - In other words: Does not cover *hail accumulation*, *wind-driven hailstones*, or *hail composition*.
- 1.25" and Lower – **Majority of Cases**
- 1.5" to 2" – **Seldom**
- 2.5" to 2.75" – **Rare**
- 3 to 4.25" – **Extremely Rare**



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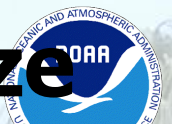


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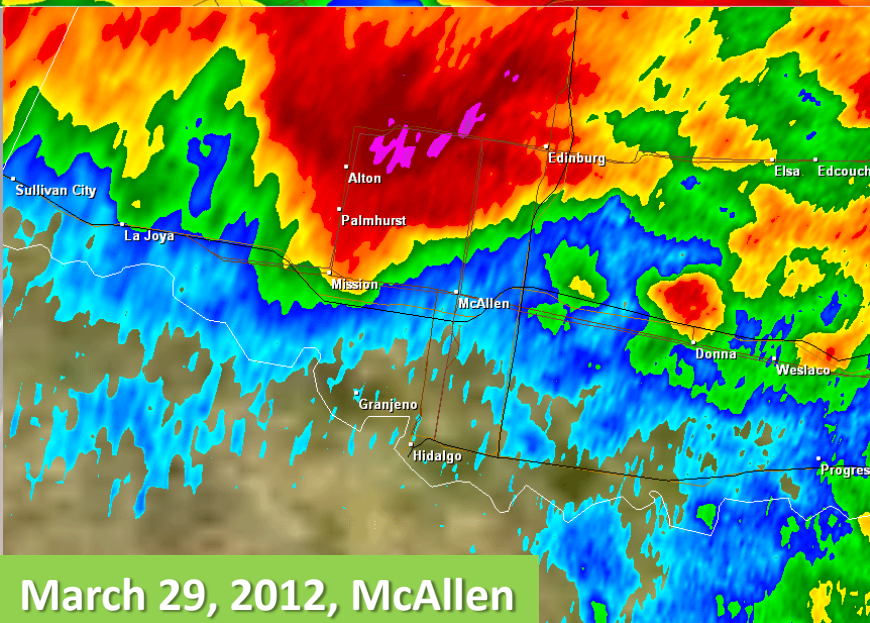
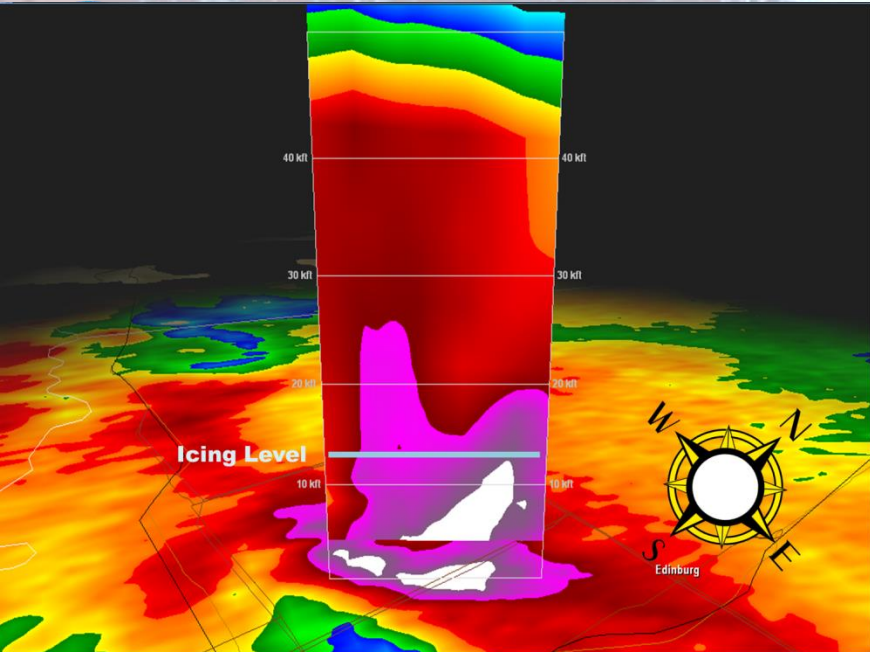
# More than Hail Size



**HAZARD...1.25 INCH HAIL.**

**SOURCE...RADAR INDICATED.**

**IMPACT... DAMAGE TO VEHICLES IS EXPECTED.**



## Verification:

- Most Stones Quarter to Half Dollar Size (good call!)
- But: Six Inches of it fell (!!)
- IBW Will Not Account for Duration or the impact from **wind-driven hail**.
- \$600 million (2015 dollars) damage from **wind-driven hail!**

**Still Need to Hand-Edit Impacts Here**

March 29, 2012, McAllen



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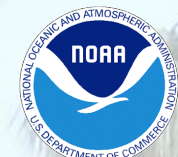


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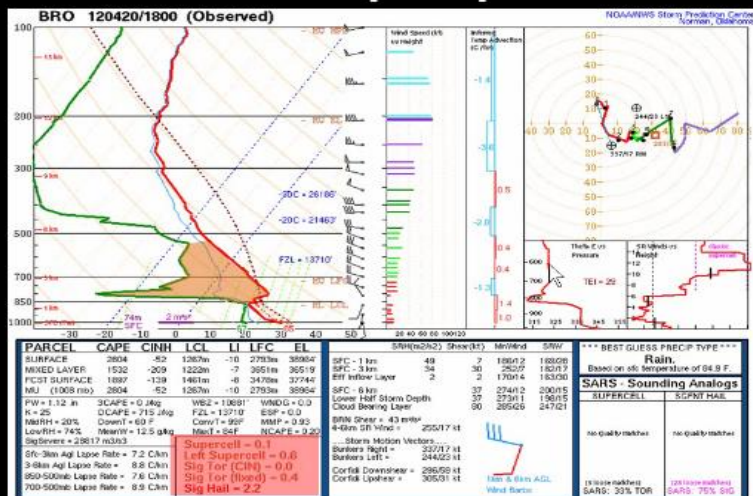




# More Than Hail Size, II



## The Setup: April 20



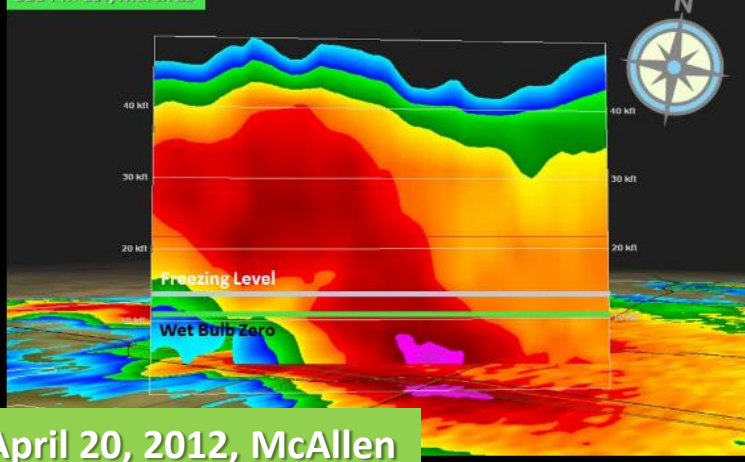
**HAZARD...2.75 INCH HAIL.**

**SOURCE...RADAR INDICATED.**

**IMPACT... PEOPLE AND ANIMALS OUTDOORS WILL BE SEVERELY INJURED AND MAY BE KILLED. EXPECT SHATTERED WINDSHIELDS AND EXTENSIVE DAMAGE TO ROOFS...SIDING...WINDOWS AND PROPERTY. MOBILE HOMES AND POORLY CONSTRUCTED HOMES MAY BE DESTROYED. SOME VEHICLES MAY BE DECLARED A TOTAL LOSS.**

## Holy Ice, Batman (Part II)

538 PM CST, March 29



April 20, 2012, McAllen

## Verification:

- Up to Softball-Sized Stones...
- ..."Soft" Hail shattered on impact in most cases
- No wind
- \$1 to 5 million (or less, 2015 dollars) damage, a small fraction of March 29th



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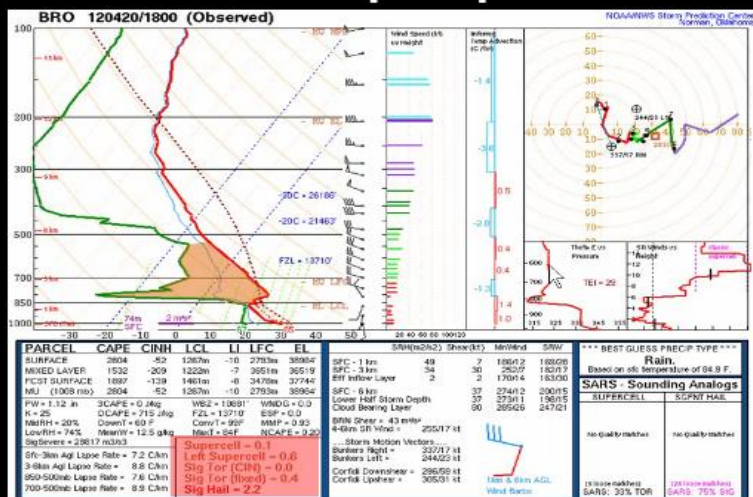


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# More Than Hail Size, II

## The Setup: April 20

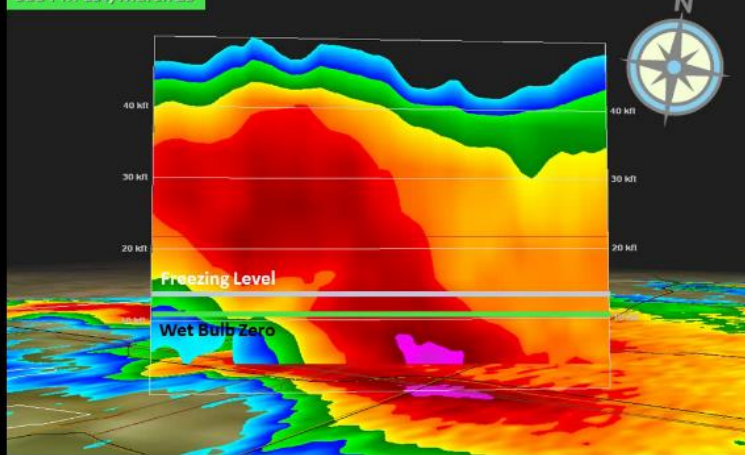


## Bottom Line?

- Hail is only based on diameter.
- Impacts can vary greatly due to:
  - Duration
  - Intensity
  - Wind
  - composition (solid ice vs. rime ice)

## Holy Ice, Batman (Part II)

538 PM CST, March 29



More research needed in all areas to best communicate true hail impacts!!



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# RGV IBW Hail Rulebook

- Tag Rule: Wind Over Hail, Hail Over Wind?

## WIND/HAIL MATRIX

	60	70	80	90	100
0.75	W	<u>W</u>	<u>W</u>	<u>W</u>	<u>W</u>
0.88	W	<u>W</u>	<u>W</u>	<u>W</u>	<u>W</u>
1.00	W	<u>W</u>	<u>W</u>	<u>W</u>	<u>W</u>
1.25	W	<u>W</u>	<u>W</u>	<u>W</u>	<u>W</u>
1.5	H	W	<u>W</u>	<u>W</u>	<u>W</u>
1.75	H	<u>H</u>	W	<u>W</u>	<u>W</u>
2.00	H	<u>H</u>	W	<u>W</u>	<u>W</u>
2.50	H	<u>H</u>	W	<u>W</u>	<u>W</u>
2.75	H	<u>H</u>	W	<u>W</u>	<u>W</u>
3.00	H	<u>H</u>	W	<u>W</u>	<u>W</u>
4.25	H	<u>H</u>	W	<u>W</u>	<u>W</u>

**Default: wind first**

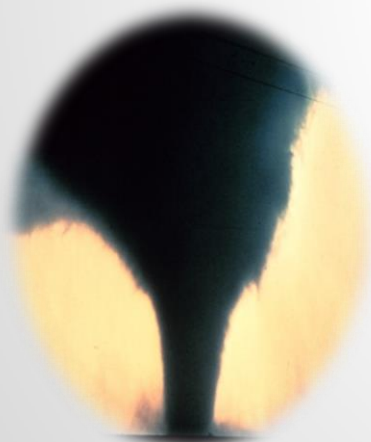
**If wind  $\geq$  70 and hail  $\geq$  1.75 .. hail first  
else if wind  $\geq$  58 and hail  $\geq$  1.5.. hail first**

# Impact Based Warning

## Experimental Product – What's Next?

### Evaluation:

- Performed by social science research groups and National Weather Service
- Using focus groups and surveys
- Media partners
- Emergency Management
- Public
- NWS Forecasters







# Impact Based Warning

## Experimental Product – Help Us Improve



<http://www.weather.gov/survey/nws-survey.php?code=IBW>



*Building a Weather-Ready Nation*

STARBUCKS  
COFFEE

Questions?

Thank You for Attending!

Barry S. Goldsmith  
Warning Coordination Meteorologist  
National Weather Service Brownsville/Rio Grande Valley, Texas



McAllen, March 30, 2012